REMARKS

Upon entry of the present Reply, claims 28-31, 36-42 and 50-72 are pending in the application. Claims 58 and 60 are amended herein to correct minor errors. Claims 32-35 and 43-45 are canceled herein. Claims 1-27 and 46-49 were cancelled previously.

Claims 53 and 64 have been withdrawn from consideration. Since the generic claims upon which the withdrawn claims depend are allowable for the reasons set forth below, Applicants respectfully request reinstatement of claims 53 and 64 into the application.

Claim 58 is amended to delete the term "also", which should have been deleted when this claim was amended previously. Claim 60 is amended to move the phrase "for a period of time sufficient to deposit the desired coating" to a more logical position in the claim, i.e., following the recitation of all the ingredients in the immersion plating solution.

Reconsideration of the application and the pending claims is respectfully requested.

Applicants hereby incorporate herein by reference the points and arguments set forth in Applicants' previous Reply to Office Action, with respect to the claims remaining in the application. For the sake of brevity, the points and arguments are not repeated herein, although Applicants submit they are fully applicable, and that the arguments have not been rebutted by the Examiner's arguments in response.

Applicants submit herewith 7 pages of documentary evidence. If the Examiner considers it necessary for an IDS to be submitted for this documentary evidence, Applicants request such indication.

Rejection of Claims over Eckles and Suzuki et al.

All of Applicants' pending claims stand rejected over the basic combination of Eckles and Suzuki et al. In the final and previous Office Actions, the Examiner has

based all of the rejections on the unsupported and erroneous contention that because Eckles teaches that a metal is immersed in an electroplating bath, that the bath thereby is an "immersion plating" bath. This contention is clearly erroneous in view of the understanding of the term "immersion plating" in the metal finishing art. Applicants submit herewith documentary evidence showing that the term "immersion plating" has a well-recognized meaning in the metal finishing arts, and that no person of ordinary skill in the art would understand or contend that an electroplating bath is an immersion plating bath. Since all of the rejections over Eckles are based upon this clearly erroneous contention, all of the rejections based on this reference should be withdrawn.

First, Applicants submit evidence taken directly from the U.S. patent literature. In addition, Applicants submit herewith two documents available to those of ordinary skill in the art clearly demonstrating the art-recognized meaning of "immersion plating".

Although a plethora of examples exist in the U.S. patent literature clearly demonstrating the art-recognized meaning and use of "immersion plating" and the complete distinction of this term from "electroplating" and cognate terms, a single example suffices to show the art-recognized meaning of this term and, thereby, the clear error of the Examiner's contention. U.S. Patent No. 4,027,055 contains the following disclosure at column 1, lines 7-46:

> Methods are well-known to plate tin over metallic surfaces. The instant baths and methods are to be distinguished from the techniques based upon electrolytic deposition and electroless plating.
>
> Electrolytic plating is the production of adherent deposits of metals on conductive surfaces carried out by passage of electric current through an electroplating solution. The plating rate is determined by the current density impressed on the surface being plated.
>
> Electroless plating is a method of metal deposition without the assistance of an external supply of electrons but, requiring an agent present in the processing solution capable of reducing the ions to be deposited. The process is further characterized by the catalytic nature of the surface which enables the metal to be plated to any thickness. Typically, such solutions comprise a solvent, a supply of ions of the metal to be deposited, an agent capable of reducing the ions of the metal to be

deposited, a complexing agent for the ions of the metal to be deposited, and a pH regulator.

Among other problems, a major difficulty is sometimes encountered with depositing electroless metal on closely defined areas. There is a tendency for non-sensitive areas after prolonged immersion in or contact with electroless metal solutions to receive scattered or random metal deposits. In addition, the electroless metal solutions sometimes produce metal deposits which contain a substantial amount of hydrogen causing the deposits to be brittle, breaking under rough mechanical handling and bending.

Immersion plating or "contact plating" depends, however, upon a galvanic displacement reaction. The current instead of being furnished from an outside source, arises from reaction of the substrate itself and the metal being plated. Because of this, metal thickness has traditionally been limited to 10 to 50 millionths of an inch. As the immersion process depends upon the electrolytic action of the base metal, deposition stops as soon as the base metal is entirely covered forming a very thin deposit.

The foregoing discussion clearly demonstrates the art-recognized differences, at least as long ago as 1977, between immersion plating and both electroless plating and electroplating. Without further belaboring the details of the distinctions between these processes, Applicants respectfully submit that the differences between electroplating and immersion plating, and the fact that the term "immersion plating" enjoys a well-recognized meaning in the art, is clear and indisputable based on the contents of this U.S. patent.

Applicants submit herewith the first three pages of "Overview of the Metal Finishing Industry", a publication available on the internet at the URL printed on each page of the publication. Beginning on page 2 of the Overview, there is a section headed "Electroplating" discussing electroplating methods. Immediately following, there is a section headed "Electroless Plating and Immersion Plating", discussing both of these techniques in turn. Without belaboring the details of the distinctions between these processes, Applicants respectfully submit that the differences between electroplating and immersion plating, and the fact that the term "immersion plating"

enjoys a well-recognized meaning in the art, is clear and indisputable based on the contents of this document.

Applicants submit herewith the first and fifth through seventh pages of "Appendix A Glossary", a publication available on the internet at the URL printed on each page of the publication. On page 5 of the Glossary, there is shown a definition of "electroless plating". On page 6 of the Glossary, there is shown a definition of "electroplating". On page 7 of the Glossary, there is shown a definition of "immersion plating". Each of these has been marked with a box. Without belaboring the details of the distinctions between these processes, Applicants respectfully submit that the differences between electroplating and immersion plating, and the fact that the term "immersion plating" enjoys a well-recognized meaning in the art, is clear and indisputable based on the contents of this document.

As exemplified by the foregoing, it is well known to any person of ordinary skill in the metal finishing arts that electroplating and immersion plating are entirely different, that the chemistry is different, the forces driving the deposition of metal upon a substrate are different, and that any ingredient useful in one of these two separate arts is not always or even often applicable to the other. Accordingly, there is no basis for contending that a material used in an electroplating bath would be useful and thereby suggested for use in an immersion plating bath.

Because Eckles relates to an electrodeposition process, and the presently pending claims are limited to immersion plating processes, Eckles is inapplicable and irrelevant to the presently disclosed and claimed invention. Since the rejections of Applicants' claims are based on Eckles as the primary reference, and, as shown by the foregoing and for the reasons set forth in Applicants' previous Reply, Eckles is not applicable, there is no basis for rejection of Applicants' claims over the prior art. Accordingly, Applicants respectfully request withdrawal of the rejections of Applicants' claims 28-31, 35-42 and 50-72, and notification that all of the pending claims are allowable.

Rejections over Wernick et al.

Claims 32-35 and 43-45 and 68-70 stand rejected over Wernick et al. Since claims 32-35 and 43-45 have been cancelled this rejection is moot with respect to the cancelled claims.

With respect to the rejection of claims 68-70, these claims were previously amended to depend from claim 60, which was previously amended into independent format, and which includes an inhibitor. Claims 68-70 are therefore considered allowable for the same reasons that claims 28-31, 36-42 and 50-67 are allowable.

Accordingly, Applicants respectfully request the rejection of claims 68-70 be withdrawn and the allowability of these claims be indicated, together with the allowability of the other pending claims.

Rejections over Suzuki in view of Zelley or "Applicants' admitted state of the art"

Claims 32-35 and 43-45 and 68-70 stand rejected over Suzuki in view of either Zelley or "Applicants' admitted state of the art." Since claims 32-35 and 43-45 have been cancelled this rejection is moot with respect to the cancelled claims.

With respect to the rejection of claims 68-70, these claims were previously amended to depend from claim 60, which was previously amended into independent format, and which includes an inhibitor. Claims 68-70 are therefore considered allowable for the same reasons that claims 28-31, 36-42 and 50-67 are allowable.

Accordingly, Applicants respectfully request the rejection of claims 68-70 be withdrawn and the allowability of these claims be indicated, together with the allowability of the other pending claims.

CONCLUSION

Based on the foregoing, Applicants respectfully submit that the presently disclosed and claimed invention patentably distinguishes over Eckles and Suzuki et al. and the assorted combinations of these references with the various tertiary references.

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If any issues remain, or if the Examiner considers that a telephone interview would be helpful to facilitate favorable prosecution of this application, the Examiner is invited to telephone the undersigned attorney.

It is believed no additional fee is required for this filing. However, if any fee is required, please charge the fee to Deposit Account No. 18-0988, Order No. ATOTP0104US.

Respectfully submitted,

RENNER, OTTO, BOISSELLE & SKLAR, LLP

DATE: July 11, 2005

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Metal Finishing Industry

Overview of the Metal Finishing Industry

These days everyone doing pollution prevention assistance seems interested in helping the metal finishing industry; ever wonder why? Metal finishing, when taken as a whole, is one of the largest users of many toxics chemicals in the country. Electroplating alone is the second largest end user of nickel and nickel compounds, and the third largest end user of cadmium and cadmium compounds. Electroplating also accounts for a substantial amount of chromium use in the United States. In other words, this industry is responsible for managing large amounts of hazardous materials (Davis 1994).

Many industries use metal finishing in their manufacturing processes including automotive, electronics, aerospace, hardware, jewelry, heavy equipment, appliances, tires, and telecommunications. Figure 1 shows the percent of markets served by metal finishers in 1992.

Figure 1. Markets Served by Metal Finishers—Percent of 1992 Market (EPA 1995a)

Why is metal finishing so prevalent? Without metal finishing, products made from metals would last only a fraction of their present lifespan because of corrosion and wear. Finishing is also used to enhance electrical properties, to form and shape components, and to enhance the bonding of adhesives or organic coatings. Sometimes the finishes are used to meet consumer demand for a decorative appearance.

Overall, metal finishing alters the surface of metal products to enhance:

- Corrosion resistance
- Wear resistance
- Electrical conductivity
- Electrical resistance
- Reflectivity and appearance (e.g., brightness or color)
- Torque tolerance
- Solderability
- Tarnish resistance
- Chemical resistance
- Ability to bond to rubber (e.g., vulcanizing)
- Hardness

Metal finishers use a variety of materials and processes to clean, etch, and plate metallic and non-metallic surfaces to create a workpiece that has the desired surface characteristics. Electrolytic plating, electroless plating, and chemical and electrochemical conversion processes are typically used in the industry. Typical supporting processes can include degreasing, cleaning, pickling, etching, and/or polishing.

Some of the materials used in metal finishing are solvents and surfactants for cleaning, acids and bases for etching, and solutions of metal salts for plating the finish onto the substrate. Figure 2 presents an overview of the fabricated metal products manufacturing process and shows the types of emissions and wastes that are generated during production.

Figure 2. Overview of the Metal Fabricating Process (EPA 1995a)

Types of Shops

The electroplating, plating, polishing, anodizing, and coloring industry is classified under the Standard Industrial Classification (SIC) code 3471 and includes establishments primarily engaged in all types of metal finishing. Companies that both manufacture and finish products are classified according to products they make. Nonetheless, they are still considered part of the metal finishing industry.

Firms that rely on one customer or that conduct metal finishing as part of a larger operation are referred to as captive shops. These companies tend to have larger operations than job shops. Independent facilities, often referred to as job shops, rely on a variety of customers and coat a variety of workpieces and substrates. In general, job shops tend to be small and independently owned. Enough similarities exist between the job and captive shops that they are essentially considered part of one industry. The job and captive shops use the same types of processes and fall within the same regulatory framework (EPA 1995a).

However, the barriers they face in deciding upon and implementing new technologies reflect the differences in their environmental performance and in the corporate capabilities of the two segments. Captive operations, which are more specialized, can focus their operations because they often work on a limited number of products and/or use a limited number of processes. Job shops, on the other hand, tend to be less focused in their operations because they can have many customers often with different requirements. In general, captive shops tend to have greater access to financial and organizational resources and, as a result, tend to be more proactive in their approach to environmental management. However, this is not always the case. The vastly different cultures in these shops greatly affects their perceived ability to implement pollution prevention (EPA 1994).

Job shops and captive shops do not ordinarily compete against each other because captive finishers seldom seek contract work. However, captive facilities might use job shops as subcontractors to perform tasks that their operations are unable to or that they choose not to do. As a nationwide trend, many manufacturers are choosing to eliminate or reduce metal finishing operations from their facilities because it is not of strategic importance for their long-term success. In some of these cases, the larger firms have shifted their plating activities to job shops (EPA 1995a).

Types of Metal Finishing Processes

Metal finishing comprises a broad range of processes that are practiced by most industries which manufacture metal parts. Typically, manufacturers perform the finishing after a metal part has been formed. Finishing can be any operation that alters the surface of a workpiece to achieve a certain property. Common metal finishes include paint, lacquer, ceramic coatings, and other surface treatments. This manual mainly addresses the plating and surface treatment processes.

The metal finishing industry generally categorizes plating operations as electroplating and electroless plating. Surface treatments consist of chemical and electrochemical conversion, case hardening, metallic coating, and chemical coating. The following sections briefly describe the major plating and surface treatment processes in order to provide a context for the more in-depth information in the chapters that follow.

Electroplating

Electroplating is achieved by passing an electric current through a solution containing dissolved metal ions and the metal object to be plated. The metal object serves as the cathode in an electrochemical cell, attracting ions from the solution. Ferrous and non-ferrous metal objects are plated with a variety of metals including aluminum, brass, bronze, cadmium, copper, chromium, gold, iron, lead, nickel, platinum, silver, tin, and zinc. The process is regulated by controlling a variety of parameters including voltage and amperage, temperature, residence times, and purity of bath solutions. Plating baths are almost always aqueous solutions, therefore, only those metals that can be reduced in aqueous solutions of their salts can be electrodeposited. The only major exception to this principle is aluminum, which can be plated from organic electrolytes (EPA 1995a).

Plating operations are typically batch operations in which metal objects are dipped into a series of baths containing various reagents for achieving the required surface characteristics. Operators can either carry the workpieces on racks or in barrels. Operators mount workpieces on racks that carry the part from bath to bath. Barrels rotate in the

plating solution and hold smaller parts (Ford 1994).

The sequence of unit operations in an electroplating process is similar in both rack and barrel plating operations. A typical plating sequence involves various phases of cleaning, rinsing, stripping, and plating. Electroless plating uses similar steps but involves the deposition of metal on metallic or non-metallic surfaces without the use of external electrical energy (EPA 1995a).

Electroless Plating and Immersion Plating

Electroless plating is the chemical deposition of a metal coating onto an object using chemical reactions rather than electricity. The basic ingredients in an electroless plating solution are a source metal (usually a salt), a reducer, a complexing agent to hold the metal in solution, and various buffers and other chemicals designed to maintain bath stability and increase bath life. Copper and nickel electroless plating commonly are used for printed circuit boards (Freeman 1995).

Immersion plating is a similar process in that it uses a chemical reaction to apply the coating. However, the difference is that the reaction is caused by the metal substrate rather than by mixing two chemicals into the plating bath. This process produces a thin metal deposit by chemical displacement, commonly zinc or silver. Immersion plating baths are usually formulations of metal salts, alkalis, and complexing agents (e.g., lactic, glycolic, or malic acids salts). Electroless plating and immersion plating commonly generate more waste than other plating techniques, but individual facilities vary significantly in efficiency (Freeman 1995).

Chemical and Electrochemical Conversion

Chemical and electrical conversion treatments deposit a protective and/or decorative coating on a metal surface. Chemical and electrochemical conversion processes include phosphating, chromating, anodizing, passivation, and metal coloring. Phosphating prepares the surface for further treatment. In some instances, this process precedes painting. Chromating uses hexavalent chromium in a certain pH range to deposit a protective film on metal surfaces. Anodizing is an immersion process in which the workpiece is placed in a solution (usually containing metal salts or acids) where a reaction occurs to form an insoluble metal oxide. The reaction continues and forms a thin, non-porous layer that provides good corrosion resistance. Sometimes this process is used as a pretreatment for painting. Passivating also involves the immersion of the workpiece into an acid solution, usually nitric acid or nitric acid with sodium dichromate. The passivating process is used to prevent corrosion and extend the life of the product. Metal coloring involves chemically treating the workpiece to impart a decorative finish (EPA 1995a).

Other Surface Finishing Technologies

Other commonly used finishing technologies that do not fall into the plating or chemical and electrochemical conversion processes include cladding, case hardening, dip/galvanizing, electropolishing, and vapor deposition. The following sections provide brief overviews of these different processes.

Cladding

Cladding is a mechanical process in which the metal coating is metallurgically bonded to the workpiece surface by combining heat and pressure. An example of cladding is a quarter. The copper inside is heated and pressed between two sheets of molten nickel alloy, bonding the materials. Cladding is used to deposit a thicker coating than electroplating, and requires less preparation and emits less waste. However, equipment costs are higher than electroplating (Freeman 1995).

Case Hardening

Case hardening is a metallurgical process that modifies the surface of a metal. The process produces a hard surface (case) over a metal core that remains relatively soft. The case is wear-resistant and durable, while the core is left strong and pliable. In case hardening, a metal is heated and molded and then the temperature is quickly dropped to quench the workpiece. An example of a material made with case hardening is the Samurai sword. The hardened

Metal Finishing Industry

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Appendix A Glossary

abrasive blasting = A method to remove brittle materials such as millscale oxide, remains of paint etc. More generally referred to as grit blasting.

acid = Chemical substance whose water solutions exhibit a pH less than 7.

acid descaling = An alternative name for "pickling" a process using acid to dissolve oxide and scale.

activation = Process of removing last trace of oxide on a metal surface and a thin layer of the metal itself to ensure that the metal surface to be plated is electrochemically active. (see "etching")

addition agent = Material used to modify the character of the deposit, usually used only in small amounts.

alkaline descaling= A chemical process for removing scale. A typical descaling solution uses caustic soda with additives such as detergents and chelating agents.

alloying = The addition of one metal to another metal or non-metal or combinations of metals. For instance, steel is an alloy of carbon and iron. Other metals are added to steels to impart specific characteristics like strength or corrosion resistance.

"Alochrom" = A proprietary process applied to aluminum and its alloys to improve corrosion resistance or to prepare surfaces for painting. Treatment produces an adherent aluminum oxide with some absorbed chromate.

amalgamating = Process in which alloys are formed with mercury such as gold, silver, iron, copper and aluminum. Due to the toxicity of mercury, use of the technique is declining.

amorphous = Structure that is non-crystalline or without a regular structure.

ampere = The current that will deposit silver at the rate of 0.0011180 grams per second. Current flowing at the rate of one coulomb.

annealing = A heat treatment process which may be applied to all metals to soften them.

anode = The positive electrode in electrolysis, at which negative and positive ions are discharged, positive ions are formed, or other oxidizing reactions occur.

anodic coating = A protective, decorative, or functional coating formed by conversion of the surface of a metal in an electrolytic oxidation process.

anodic etching = A form of electrolytic etching where the workpiece is being etched is anodic in the electrolytic circuit (in electroplating, the workpiece is the cathode).

anodizing = A process generally applied to aluminum and its alloys to produce an adherent oxide film to impart corrosion resistance or surface hardness.

anolyte = The portion of an electrolyte in the vicinity of the anode. In a divided cell, the portion of the electrolyte that is on the anode side of the diaphragm.

aquablast = A surface cleaning process which can be applied to any material where an abrasive material is suspended in water. The resulting slurry is pressurized and ejected through a nozzle. Since higher pressures can be

instances it is inconspicuous. Various methods are used for this process including blasting, pickling, acid or alkaline sodium hydride treatments, and polishing.

die-casting = A method of casting in which molten metal is poured, sometimes under pressure, into a mold or die. The die is made of metal and immediately after solidification of the casting the die opens and the casting is ejected.

diffusion coating = An alloy coating produced by applying heat to one or more metal coatings deposited on a metal.

distribution = Refers to the uniformity of the metal deposited from a plating process.

dragin = The water or solution that adheres to workpieces introduced into a bath.

dragout = The solution that adheres to a workpiece removed from a bath.

dry blasting = A general name given to any form of blasting where the abrasive agent is not carried in water.

dry-form lubrication = A form of painting applied to steel surfaces of workpieces subject to light wear or abrasion. It generally uses colloidal or molybdenum disulfide carried in a phenolic resin.

ductility = Refers to the flexibility of an electroplated deposit; this parameter is critical when bending and forming operations occur after plating.

dummy (dummy cathode) = A cathode in a plating solution that is not to be used after plating; often used for removal or decomposition of impurities.

effluent = Any gas or liquid emerging from a pipe or similar outlet; usually refers to waste products from chemical or industrial plants as stack gases or liquid mixtures.

electrocleaning = An electrochemical cleaning process by which a workpiece is first made the cathode in an electrolytic cell. When current is applied, the generation of hydrogen gas from the electrolysis of water at the surface of the workpiece results in a highly efficient scrubbing action. Following initial treatment as a cathode the circuit is reversed so that the workpiece is the anode. Oxygen gas, which is generated at the surface produces a final cleaning action.

electrode = A conductor through which current enters or leaves an electrolytic cell at which there is a change from conduction by electrons to conduction by charged particles of matter or vice versa.

electrode potential = The difference in potential between an electrode and the immediately adjacent electrolyte.

electroforming = A specific form of electroplating used where intricate shapes and relatively thin metal deposits are required. Molds of plastic, wax, or sometimes metals are made conductive by application of carbon or metallic powder and are plated by conventional methods. Nickel, copper, or precious metals are generally selected for this form of plating. The mold is generally removed at the completion of the plating process by one of a number of methods depending on the material from which the mold is constructed.

electrogalvanizing = Electrodeposition of zinc coatings.

electroless plating = The process of depositing metal from a water-based solution using chemical catalysts for the metal cation reduction process. In this process no external potential (electrical current) is applied.

electrolyte = A conducting medium in which the flow of current is accompanied by movement of matter; most often an aqueous solution of acids, bases, or salts, but includes many other media such as fused salts, ionized gases, and some solids.

electrolysis = Production of chemical changes by the passage of current through an electrolyte.

electrolytic etch = A technique generally applied to steels which attack the surface to produce a clean, oxide free

material. It is often used prior to electroplating, especially chromium plating. Since it preferentially attacks edges it will open us small cracks in the surface of the workpiece. Due to this, this process can be used to inspect finishes for flaws.

electrolytic polishing = An electrochemical process usually applied to steels, aluminum, and aluminum alloys. This process produces a surface that is bright and highly reflective. In most instances this is used for decorative purposes and is often used in conjunction with some other form of metal finishing such as anodizing, plating, or lacquering.

electroplating = The process of depositing metal from an aqueous solution using an external potential (electrical current) for the metal cation reduction process; usually, the potential applied is DC, but can approach controlled AC with some sophisticated switching devices (pulsed electroplating).

electro-osmosis = See "reverse osmosis"

electrorefining = The process of anodically dissolving a metal from an impure anode and depositing it cathodically in a purer form.

electrowinning = The production of metals by electrolysis with insoluble anodes in solutions derived from ores or other materials.

emulsion cleaning = A cleaning technique which acts by emulsifying contaminants. Emulsions are mixtures of two liquids, with one liquid holding the other in a suspension similar to colloidal suspension. The liquids will typically have different polarities and will dissolve different types of materials. One of the liquids is usually water and the other will have non-polar properties. They can therefore be used to dissolve non-polar contaminants like oil and grease from metal surfaces.

etching = Etching is sometimes used a surface preparation technique prior to electroplating or for removal of metal such as in the printed circuit industry where material not required on the finished product is removed by a chemical solution. It can also be used as an inspection technique due to its ability to accentuate surface cracks and defects.

"ferrostan" process = A method of continuous electrolytic tin plating of steel strip in which cold reduced strip is continuously fed through the cleaning, etching, plating, and rinsing processes. The solution is generally acid sulfate which produces a matte finish.

filtration = A means of separation where constituents are separated usually by physical methods.

fire gilt process = A process used exclusively in the jewelry trade in which gold dissolved in mercury (gold amalgam) is wiped on surfaces to be plated. When the article is heated the mercury is driven off leaving a gold film. The process represents a considerable health hazard due to the emission of the mercury vapor.

flocculation = The combination or aggregation of suspended colloidal particles in such a way that they form small clumps; usually used in conjunction with additive chemicals (flocculants) to treat wastewater.

fluxing = A process used in the heating of metals which may be intended to reduce or eliminate oxidation, confine the products of oxidation, reduce their melting point, and improve fluidity of surface metal layers. Fluxing is generally used in casting, welding, and soldering.

foam blanket = An additive that forms a layer on the surface of electroplating baths that have poor anode/cathode efficiency, to prevent any mist or spray from escaping.

fouling = Deposition of materials on a membrane surface or within the pores because of soluablility limits (at the surface) or pore size and/or shape.

free cyanide = (1) *Calculated* - the concentration of cyanide or alkali cyanide present in solution in excess of that calculated as necessary to form a specified complex ion with a metal or metals present in solution. (2) *Analytical* - the free cyanide content of a solution as determined by a specified analytical method.

frosting = A type of metal finishing where a fine matte finish is produced by using techniques such as acid-etching, blasting, scratch brushing or barreling.

galvanic cell = An electrolytic cell capable of producing electrical energy by electrochemical action.

galvanic protection = A general term used in the corrosion protection of steel. Technically, it refers to a metal used to protect a metal higher than itself in electrode potential. In practice, it refers to the use of zinc to protect steel.

galvanizing = A corrosion protection technique applied only to mild steel, cast iron, and steel alloys in which workpieces are immersed in liquid zinc at 500 degrees Celsius. A zinc/iron alloy is formed at the surface of the workpiece giving it an adherent coating of zinc. Prior to galvanizing, the metal surface must be in a state of moderate cleanliness. This is generally accomplished by light acid pickling or blasting. Galvanized coatings are generally about 0.005 inches thick and can give protection for 10 to 20 years.

gilding = A process in which gold is coated on the surface of another base metal. Gold leaf, a layer beaten so thin it is porous to light, is glued or beaten onto the article to be gilded. A similar method applies a fine gold powder mixed with a flammable liquid solvent applied to the article like a paint. The solvent is allowed to evaporate or in some cases may be ignited.

gold plating = gold has two specific properties which make it valuable in industrial and commercial uses, it resists oxidation and corrosion to a very high degree and it retains its attractive color. The main advantage of gold plating over other methods of applying gold to surfaces, is that electroplated coatings do not have pores as gilded coatings do. This provides significantly longer lifespans and corrosion resistance.

grit blasting = A technique of abrasive cleaning or surface preparation using sharp particles (e.g., cast iron shot, aluminum oxide). It covers such processes as removal of scale, corrosion, paint and other surface films. Use of free silica presents a health threat and should be avoided.

hard chromium = Chromium plate for engineering rather than decorative applications; not necessarily harder than the latter, but generally thicker or heavier. See "chromium plating".

hard facing = A term referring to processes used to harden metal surfaces and impart wear resistance by a variety of heat treatments. See "metal spraying".

HCD (High Current Density) = High amperes per surface area.

hot dip coating = See "galvanizing".

hydrogen embrittlement = A defect which occurs during the electroplating process. Atomic hydrogen is produced at the cathode of the workpiece being plated. This atomic hydrogen is extremely reactive and has the capability of entering the interstices of the metal. Being unstable in the atomic state, the hydrogen will combine as rapidly as possible with other atoms to form molecular hydrogen. This molecular hydrogen, having a higher unit volume than atomic hydrogen results in internal pressure in the plated metal.

immersion plating = A plating technique similar to electroless plating where a more electropositive metal is dissolved in an electrolyte and is plated onto the surface of a less electronegative metal workpiece. The term immersion plating is used where a deposit is obtained and the plating process then stops. This is distinguished from electroless plating where the deposition of the metal being plated continues to deposit as long as the workpiece remains in the solution.

inchrom process = see "Chromizing".

indicator (pH) = A substance that changes color when the pH of the medium is changed; in the case of most useful indicators, the pH range within which the color changes is narrow.

indium plating = Indium is a metal not unlike lead but with friction and corrosion resistance properties that are